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# SeaWiFS Postlaunch Technical Report Series

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# Volume 21, The Eighth SeaWiFS Intercalibration Round-Robin Experiment (SIRREX-8), September–December 2001

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# *Chapter 1*

## SIRREX-8 Overview

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Abstract

The primary objective of SIRREX-8 was a thorough inquiry into the uncertainties associated with the general problem of determining the immersion factors for marine radiometers, and restricting the analysis to Satlantic in-water Ocean Color Irradiance 200-series sensors (the so-called OCI-200 instruments). A small team of investigators was assembled to address these points at three different facilities (the diversity in participants assured no one peculiarity in one of the methods could bias the results). The secondary SIRREX-8 objective was to measure the cosine response of one sensor at two of the participating facilities. Although up to 12 sensors were measured, 9 were rotated through all three facilities. The instrumentation came primarily from two different organizations with differing measurement objectives, so the assembled sensors had a diverse range of calibration histories, ages, intended uses, sensitivities, saturation levels, etc. The diversity in sensors means a significant subset of the results will have a wider applicability to the larger community.

### 1.1 INTRODUCTION

When a cosine collector is immersed in water, its light transmissivity is less than it was in air. Irradiance sensors are calibrated in air, however, so a correction for this change in collector transmissivity must be applied when the in-water raw data are converted to physical units. The correction term is called the immersion factor, and it must be determined experimentally, using a laboratory protocol, for each sensor wavelength, $\lambda$.

When the sensor is illuminated, the raw optical data samples at each wavelength are recorded as digitized voltages, $V(\lambda)$, usually in counts. Each sample is recorded at a particular time, $t_i$, which also sets the depth, $z$. Raw irradiance data are typically converted to physical units using a calibration equation of the following form:

$$E(\lambda,t_i) \;=\; C_c(\lambda)\, I_f(\lambda) \left[V(\lambda,t_i) \;-\; \bar{D}(\lambda)\right], \qquad (1)$$

where $E(\lambda,t_i)$ is the calibrated irradiance, $C_c(\lambda)$ is the calibration coefficient (determined during the radiometric calibration of the sensor), $I_f(\lambda)$ is the immersion factor†, and $\bar{D}(\lambda)$ is the average bias or dark voltage measured during a special *dark cast* with the caps on the radiometer. The difference between $V(\lambda,t_i)$ and $\bar{D}(\lambda)$ is the net signal level detected by the radiometer while exposed to light.

In some cases, dark voltages are replaced by so-called *background* or *ambient* measurements, so illumination biases can be removed along with the dark correction. For the purposes of SIRREX-8, background data were collected with the direct illumination of the target by the source occulted by an intervening *on-axis baffle*, so only indirect light (from the source and any other light emissions from equipment in the room) reached the sensor aperture. Ambient data were collected with the source off, so only illumination from other light-emitting devices in the room reached the sensor aperture.

In the formulation given in (1), the irradiances measured during ocean color field campaigns are usually the in-water downward irradiance, $E_d(z,\lambda)$, the in-water upwelled irradiance, $E_u(z,\lambda)$, and the above-water total solar irradiance, $E_d(0^+,\lambda)$. In some data processing schemes (Hooker et al. 2001), there is an explicit attempt to try and get the extrapolated in-water downward irradiance to agree with the measured above-water total solar irradiance over the time period associated with the extrapolation interval, so the application of the immersion factor to the former must be accurate.

† For the purposes of the calibration equation, the immersion factor for an above-water irradiance sensor is always equal to unity.